MOTOR-COMPRESSOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a motor-driving-circuit-integrated motor-compressor consisting of an electric motor for driving a compressor mechanism which sucks and compresses refrigerant, and a motor-driving circuit, such as an inverter circuit or the like for driving the motor, integrated with the motor and is effectively applied to a vapor compression type refrigerating system.

2. Description of the Related Art

A conventional motor-compressor is disclosed in Japanese unexamined Patent Publication No.2002-70743. This motor-compressor is provided with a casing, in which a motor driving circuit is accommodated, mounted on the outer surface of the motor housing in which a motor for driving the compressor mechanism is accommodated. This casing is provided with an inverter output terminal connected to the motor driving circuit, and the motor housing is provided with a sealed terminal for input to the motor. The inverter output terminal and the sealed input terminal are connected with each other through lead wires.

However, the conventional motor-compressor described above has a problem that the work of connection between the inverter output terminal and the sealed input terminal at the manufacture of the motor-compressor is complicated because the both terminals are connected to each other through lead wires which are electrical connecting means.

SUMMARY OF THE INVENTION

The present invention has been developed in view of the above problem and aims to provide a motor-compressor capable of simplifying the work of connection between the

output terminal on the motor driving circuit side and the input terminal on the motor side.

In order to achieve the above aim, a motor-compressor according to the present invention comprises:

an electrical motor (120) for driving a compressor mechanism (110) which sucks and compresses refrigerant;

a motor housing (121) in which the motor (120) is accommodated and fluid flows;

a driving circuit board (130) which is mounted on the outside of the motor housing (121) and on which a motor driving circuit for driving the motor (120) is formed;

an output terminal (137) which is mounted on the driving circuit board (130) and outputs driving power for the motor (120); and

an input terminal (124), which penetrates the motor housing (121), for inputting the driving power to the motor (120) while sealing the motor housing (121) against leakage of the fluid,

wherein the output terminal (137) and the input terminal (124) are directly engaged and electrically connected with each other.

In this configuration, the output terminal (137) and the input terminal (124) can be directly connected to each other without through any connecting means. Thus, the work of connection between the output terminal (137) and the input terminal (124) can be simplified.

Furthermore, in the present invention,

the input terminal (124) has an engagement protrusion (124a) protruded to the outside of the motor housing (121),

the output terminal (137) has an engagement hole (137a) corresponding to the shape of the engagement protrusion (124a), and

the engagement protrusion (124a) and the engagement hole (137a) are engaged with each other so that the output terminal (137) and the input terminal (124) are

electrically connected with each other.

In this configuration, the engagement protrusion (124a) of the input terminal (124) is engaged with the engagement hole (137a) of the output terminal (137), so that the output terminal (137) and the input terminal (124) can be electrically connected with each other.

Furthermore, in the present invention, the engagement protrusion (124a) and the engagement hole (137a) are both shaped, substantially, as a pillar.

In this configuration, the engagement protrusion (124a) and the engagement hole (137a) can be formed easily, and the work of engagement between the engagement protrusion (124a) and the engagement hole (137a) is also easy.

Furthermore, in the present invention, the engagement protrusion (124a) and the engagement hole (137a) are both shaped, substantially, as a column.

In this configuration, the engagement protrusion (124a) and the engagement hole (137a) can be formed more easily, and the work of engagement between the engagement protrusion (124a) and the engagement hole (137a) is also easier.

Furthermore, in the present invention, the driving circuit board (133) has a conductor pattern (136) connected with the output terminal (137), and is formed of resin by insert molding together with the output terminal (137) and the conductor pattern (136).

In this configuration, when the driving circuit board made of resin on which the conductor pattern (136) is formed by insert molding is formed, the output terminal (137) can be easily formed on the driving circuit board (133).

Furthermore, in the present invention, a resin casing (131a) for the driving circuit board is comprised such that a space for accommodating the driving circuit board (130) is provided, and the driving circuit board (133) and the casing (131a) for driving circuit board are

molded in one piece.

In this configuration, when the driving circuit board (133) made of resin on which the output terminal (137) and the conductor pattern (136) are formed by insert molding is formed, the casing (131a) for driving circuit board can be formed at the same time.

Furthermore, in the present invention, fluid flowing in the motor housing (121) is a sucked refrigerant and will be sucked by the compressor mechanism.

In this configuration, the temperature of the sucked refrigerant is relatively low, so that it is possible to cool the motor (120). Further, the input terminal (124) is able to prevent the sucked refrigerant from leaking out of the motor housing (121).

The present invention may be more fully understood from the description of preferred embodiments of the invention, as set forth below, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig.1 is a schematic diagram of a vapor compression-type refrigerating cycle in which a motor-compressor according to a first embodiment of the present invention is used;

Fig.2A is a schematic structural side view, partially cut-away, of the motor-compressor according to the first embodiment; Fig.2B is a side view, partially cut-away, of the motor of the motor-compressor; Fig.2C is a cross sectional view taken along the line II-II of Fig.2B;

Fig.3 is an enlarged cross sectional view of part A shown in Fig.2A; and

Fig.4 is a schematic structural side view, partially cut-away, of a motor-compressor according to a second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention are described

below on the basis of the drawings.

(First Embodiment)

Fig.1 is a schematic diagram of a vapor compression type refrigerating cycle for a vehicle using a motor-driving-circuit-integrated motor-compressor (hereinafter referred to compressor) 100 according to a first embodiment of the present invention.

Reference numeral 200 denotes a radiator (condenser) for cooling the refrigerant discharged from the compressor 100. Reference numeral 300 denotes a receiver (gas-liquid separator) for separating the refrigerant flowing out of the radiator 200 into gaseous refrigerant and liquid refrigerant to discharge the liquid refrigerant and store surplus refrigerant in the refrigerating cycle.

Reference numeral 400 denotes an expansion valve of a decompressing means for decompressing the liquid refrigerant which has flowed out of the receiver 300. Reference numeral 500 is an evaporator for evaporating the refrigerant decompressed by the expansion valve 400. In this embodiment, an expansion valve 400 is adopted as the decompressing means. However, this embodiment is not limited thereto, and a fixed restrictor or the like may be adopted as the decompressing means.

Next, the structure of the compressor 100 will be explained.

As shown in Fig.1, the compressor 100 comprises a compressor mechanism 110 (scroll-type compressor mechanism in this embodiment) which sucks and compresses refrigerant, an electrical motor 120 (brushless DC motor in this embodiment) for driving the compressor mechanism 110, and a driving circuit board 130 on which an inverter circuit, which is a motor driving circuit for driving the motor 120, and the like, are formed.

Reference numeral 111 denotes a compressor mechanism housing made of aluminum alloy in which the compressor mechanism 110 is accommodated. Reference numeral 121

denotes a motor housing made of aluminum alloy in which the motor 120 is accommodated. The compressor mechanism housing 111 and the motor housing 121 constitute a housing of the compressor 100.

On the motor housing 121, as shown in Fig.1, a suction port 123 connected to the refrigerant-outlet of the evaporator 500 is formed. On the compressor mechanism housing 111, as shown in Fig.1, a discharge port 112 connected to the refrigerant-inlet of the radiator 200 is formed. Reference numeral 131 denotes a casing for driving circuit board in which the driving circuit board 130 is accommodated.

The scroll-type compressor mechanism 110 described above enlarges or reduces the volume of the working chamber by rotating the movable scroll against the fixed scroll, and the fixed scroll serves as part of the compressor mechanism housing 111.

Fig.2A is a side view, partially cut-away, of the compressor 100. Fig.2B is a side view, partially cut-away, of the motor 120 of the compressor 100. Fig.2C is a cross sectional view of the motor 120. The motor 120 consists of a stator 127 and a rotor 128, and the rotor 128 is fixed to the rotating shaft 128a rotatably supported by the bearing 128b.

As shown in Fig.2A, a metal casing 131 is provided on the upper side of the motor housing 121. In the casing 131, the driving circuit board 130 is provided. The bottom face 122 of the inside (space for accommodating the driving circuit board 130) in the casing 131 is the outer face of the motor housing 121.

The driving circuit board 130 consists of a circuit board 132 containing electrical elements 134 and a circuit board 133 containing electrical elements 135, and is supported by a supporting portion 122a mounted on the bottom face 122. The circuit board 132 is a so-called rigid printed board in which a conductor pattern, etc. are formed on a insulating substrate made of epoxy resin,

etc.

On the other hand, the circuit board 133 is a molded board made of resin (polybutylene terephathalate in this embodiment), in which bus bars 136, which are high stiffness conductors constituting a large-current circuit pattern, etc. of the motor driving circuit, are provided so as to be laminated between resin, and an output terminal 137 is shaped like a cylinder by insert molding so as to be joined to the bus bars 136 and disposed in such a manner that it penetrates the circuit board 133 in a direction perpendicular to the board plane. The electrical elements 135 contained in the circuit board 133 are heating elements of relatively high heating values and are disposed so as to make contact with the bottom face 122.

Reference numeral 124 denotes an input terminal penetrating the motor housing 121. The input terminal 124 is connected with lead wires 126 inside the motor housing 121 so that driving power for the motor 120 (see Fig.1) which has been input from the input terminal 124 is supplied to the motor 120 (see Fig.1) through the lead wires 126.

Fig.3 is an enlarged cross sectional view of part A shown in Fig.2A.

As shown in Fig.3, the input terminal 124 penetrating the motor housing 121 is a conductor shaped like a column, and is supported by the motor housing 121 through a sealing material layer 124c filled between the motor housing 121 and the input terminal 124. In this embodiment, glass is used as sealing material to form the sealing material layer 124c.

The sealing material layer 124c electrically insulates the input terminal 124 from the motor housing 121, and constitutes a sealing structure in order to prevent the refrigerant flowing in the motor housing 121, described later, from leaking out of the motor housing 121. The inner protrusion 124b of the input terminal 124

protruding inside the motor housing 121 is connected with the lead wires 126 described above. Further, the outer protrusion 124a of the input terminal 124 protruding outside the motor housing 121 is designed to be engaged and connected to the engagement hole 137a of the output terminal 137 described later. The outer protrusion 124a is the engagement protrusion in this embodiment.

The input terminal 124 consists of three elements in this embodiment. Only one of the three elements is shown in the figure, and the other elements are not shown in the figure.

The output terminal 137, inserted in the circuit board together with the bus bar 136, is shaped like a cylinder. In the output terminal 137, an engagement hole 137 engaged with the input terminal 124 is formed. The engagement hole 137a is shaped like a column (the cross section in the horizontal direction in the figure is shaped like a column) corresponding to the shape of the outer protrusion 124a of the input terminal 124.

The outer protrusion 124a of the input terminal 124 is press-fitted in the engagement hole 137a of the output terminal 137 so that the input terminal 124 is electrically connected to the output terminal 137 and driving power is supplied from the driving circuit board 130 to the motor 120.

The bus bars 136 inserted in the circuit board 133 constitute the conductor pattern, in this embodiment, which is connected with the output terminal 137, and the circuit board 133 formed by insert molding, together with the output terminal 137 and the bus bar 136, corresponds to the substantial driving circuit board in the present invention.

Next, the operation of the compressor 100 will be described on the basis of the above configuration.

When the motor 120 of the compressor 100 is driven by the power supplied through the output terminal 137 and the input terminal 124 from the driving circuit board

130, the motor 120 drives the compressor mechanism 110 coupled with the motor 120 to causes the compressor mechanism 110 to suck the refrigerant. At the same time, low temperature gaseous refrigerant (sucked refrigerant) flows into the motor 120 from the suction port 123. The refrigerant which has flowed into the motor 120 from the suction port 123 cools the motor 120 while flowing in the motor housing 121, and then is sucked and compressed by the compressor mechanism 110. The refrigerant compressed by the compressor mechanism 110 becomes high temperature gaseous refrigerant, which is discharged from the discharge port 112.

Part of the sucked refrigerant flowing from the suction port 123 to the compressor mechanism 110, when the compressor mechanism 110 is driven, flows the upper inside of the motor housing 121 shown in Fig.2B. This sucked refrigerant absorbs, through the motor housing 121, the heat from the electrical elements 135, which are main heat sources in the inverter circuit, and cools the casing 131 through the motor housing 121. Thus, the driving circuit board 130, on which the inverter circuit, etc. are formed, is efficiently cooled.

In the above configuration, the outer protrusion 124a of the input terminal 124 and the engagement hole 137a of the output terminal 137 are directly engaged to each other, so that the output terminal 137 and the input terminal 124 are electrically connected to each other. Thus, the output terminal 137 and the input terminal 124 can be directly connected to each other without connecting means such as lead wires or the like, so that the work of connection between the output terminal 137 and the input terminal 124 can be simplified.

Furthermore, the number of components of the compressor 100 can be reduced more than when using connecting means. Further, the output terminal 137 and the input terminal 124 are not disposed apart from each other, which contributes to the downsizing of the

compressor 100.

Furthermore, the outer protrusion 124a of the input terminal 124 and the engagement hole 137a of the output terminal 137 are both shaped like a column, so that the outer protrusion 124a and the engagement hole 137a are formed easily and the work of engagement between the outer protrusion 124a and the engagement hole 137a is also easy. Further, the contact area between the outer protrusion 124a and the engagement hole 137a can be secured easily, so that secure electrical connection between the input terminal 124 and the output terminal 137 is possible.

Furthermore, the circuit board 133 is formed of resin, by insert molding, together with the output terminal 137 and the bus bar 136 connected to it. Thus, the output terminal 137 can be easily formed on the driving circuit board 130. In addition, in contrast to a case that the output terminal 137 is provided separately from the driving circuit board 130, the work of connection between the output terminal 137 and the driving circuit board 130 is not required, and the size of the compressor 100 can be reduced.

(Second Embodiment)

Next, a second embodiment will be described on the basis of Fig.4. The configuration of the casing 131 of the second embodiment is different from that of the first embodiment described above. The same components as the first embodiment are shown with the same notations, and descriptions of these components are omitted.

As shown in Fig.4, the casing 131 of this embodiment consists of a box portion 131a having a substantially rectangular tube structure with top and bottom wide openings, and a cover portion 131b made of metal plate disposed so as to cover the top opening of the box portion 131a. The box portion 131a and the circuit board 133 accommodated in it are molded in one piece.

In this configuration, the same effect as the first

embodiment can be obtained. In addition, when the circuit board 133 is formed, part of the casing for driving circuit board 131 can be formed at the same time. Further, the circuit board 133 is supported by the box portion 131a of the casing 131, so that the number of processes for assembling the construction can be further reduced.

(Other Embodiments)

In the above embodiments, the column-shaped outer protrusion 124a of the input terminal 124 is engaged and connected with the column-shaped engagement hole 137a of the output terminal 137. However, the present invention is not limited thereto provided that the input terminal 124 and the output terminal 137 are directly engaged and connected with each other.

The outer protrusion 124a and the engagement hole 137a may be both shaped like a prism. Further, shapes of the outer protrusion 124a and the engagement hole 137a are not limited to the shape of a prism, that is, the outer protrusion 124a may not have the same shape as the engagement hole 137a, elongated in the direction of press-fitting the outer protrusion 124a into the engagement hole 137a, and may partially have a diameter-enlarged portion or the like in consideration of a latched state at engagement and the like. Further, the input terminal 124 may have a engagement hole in which an engagement protrusion formed on the output terminal 137 is engaged.

Furthermore, in the second embodiment described above, the circuit board 133 in which the bus bar 136, etc. are inserted, and the box portion 131a of the casing 131 are molded in one piece. However, bus bars, etc. may be inserted also in the box portion 131a to be used as part of the driving circuit board.

Furthermore, in the above embodiments, the casing 131 is formed on the upper side of the motor housing 121 shown in Fig.2A or Fig.4. However, the position of the

casing 131 is not limited thereto. For example, the casing 131 may be formed on the right side of the motor housing 121 shown in Fig.2A or Fig.4.

Furthermore, in the above embodiments, fluid flowing in the motor housing 121 is sucked refrigerant. However, the fluid is not limited thereto. For example, if it is not necessary to cool the motor 120 and the driving circuit board 130, the fluid may be discharged refrigerant.

Furthermore, in the above embodiments, the driving circuit board 130 is disposed in a space in the motor housing 121. However, silicon gel or the like may be potted in the casing 131 for the purpose of insulation and/or water-resistance.

Furthermore, in the above embodiments, the compressor 110 is a scroll compressor. However, the compressor 110 is not limited thereto, and may be a vane compressor, a swash plate type variable displacement compressor, or the like. Further, the positions of the discharge port 112 and suction port 123 are not limited to the positions in the above embodiments provided that sucked refrigerant flows in the motor casing if it is necessary to cool the motor 120 and/or the driving circuit board 130.

Furthermore, in the above embodiments, the motor 120 is a brushless motor. However, the motor is not limited thereto and may be an alternating-current motor or the like. Further, the motor driving circuit is an inverter circuit. However, the motor driving circuit is not limited thereto and may be a circuit, for driving a direct current motor, using chopper control method for example.

While the invention has been described by reference to specific embodiments chosen for purposes of illustration, it should be apparent that numerous modifications could be made thereto by those skilled in the art without departing from the basic concept and

scope of the invention.